Bubble Chamber Physics Laboratory(Annual Report)

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Bubble Chamber Physics Laboratory

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Research Activities

This laboratory is conducting the experimental investigations on the elementary particles by the bubble chamber experiment. Most of experiments are carried by using large accelerator facilities at USA laboratories and the picture measurements and data analyses are carried at Tohoku.

The following are the major subjects in 1984.

I. ν-D Interactions at High Energy

338K pictures of ν-D interactions were taken at the Fermilab 15 foot bubble chamber in the period of November 1978 - January 1979. (E-545 Collaboration; Illinois Institute of Technology, Maryland University, State University of NY at Stony Brook, Tohoku University and Tufts University). The ν beam was produced by 350 GeV protons with a single horn wide band beam system. Physics topics published or reported are, (1) the ratio of ν-n and ν-p cross sections, (2) structure functions in n and p, (3) quark charge flow, (4) jet structures due to single quark and to di-quark, (5) QCD effects, (6) V^{o} production, (7) vector meson production, (8) charmed particle production and (9) Neutral current. In addition, the hot topics on the quark structure in nucleus (EMC effect) is being analyzed in the reaction ν + Fe comparing with the ν + D_2 data from this experiment. The results of the data analysis indicate the clear EMC effect in

II. ν-D Interactions at Low energy

800K pictures of ν-D interactions were taken at the Brookhaven National Laboratory 7-foot Bubble Chamber in the period of July 1978 - April 1979. (E-737 Collaborations; Brookhaven National Laboratory and Tohoku University). The ν-beam was produced by 33 GeV protons with a wide band horn system. The analysis of the strange particle production and one/two pion productions in charged current reaction are in progress. The study of neutral current reaction are complete. The cross section ratio R = NC/CC is measured to be 0.16 ± .03 supporting the Weinberg-Salam structure of neutral currents. The papaer was published in Phys. Rev. Rapid Communication. We are now summarizing the data on ν quasielastic scattering and single pion production reactions.

III. γ-p Interactions at 20 GeV

The photoproduction of charmed particles are investigated by using the Stanford Linear Accelerator Center 40 inch hybrid system. 20 GeV photons were produced from the backward scattering of laser light from the 30 GeV SLAC linear Accelerator electron beam. This experiment is a world wide collaboration, USA, Britain, Israel and Japan. The continuation of this experiment was started from Spring 1983 as BC 75 and ended in Dec. 1983. In this run period, 1.2×10^6 pictures were taken. A total of 3.6×10^6 pictures was taken from summer 1980 to fall 1983. The first charm event was found at Tohoku in the collaboration. Based on 22 neutral and 21 charged charm D events, the cross section and the lifetimes were measured to be

$$\sigma(\gamma p \rightarrow \text{charm}) = 56 \, {}^{+\,24}_{-\,23} \text{ (nb) at 19.5 GeV}$$

$$\tau^{\pm} = 7.6 \, {}^{+\,2.3}_{-\,2.0} \times 10^{-13} \text{sec}$$

$$\tau^{o} = 6.8 \, {}^{+\,2.3}_{-\,1.8} \times 10^{-13} \text{sec}$$

$$\tau^{\pm}/\tau^{o} = 1.1 \, {}^{+\,0.9}_{-\,0.3}$$

The present $\tau^{\pm}/\tau^{o}$ ratio is close to 1 against the most of past data of around 3. These data is stimulating the argument on charm decay mechanism.

In addition to the charm Study, the study of strange particle production in γ + p interactions was completed for publication (Phys. Rev.)

IV. Positive hadron interactions on hydrogen and heavy nuclei at 200 GeV/c

550K pictures were taken at Fermilab using the 30 inch bubble chamber hybrid system in two runs of May 1981 and March 1982. The beam is a 200 GeV/c positive beam, and $p/K^+/\pi^+$ are identified by the upstream counter system. Mg, Ag and Au foils are installed inside the hydrogen bubble chamber. The multiplicity in hadron$^+$-A interactions was analysed, and the two components of burst and non-furst type nuclear interactions were observed. The measurement and analysis is being continued.

V. Beam dump experiments, E636

The beam dump experiment for the search of tau-neutrino, E636, was aprroved by Fermilab for the coming 100 GeV TEVATRON. The Tohoku 1m Freon bubble chamber for this experiment is constructed in Japan; Also, the prototype laser holography system is being tested in our laboratory for obtaining 30μ m resolution everyshere inside the 1 meter bubble chamber. The first test run of this chamber was done at IHI in June 1983 and was very successful. The chamber is now being reassembled at Fermilab and used as a preliminary run in E745.

VI. Tevatron neutrino experiment, E745

The neutrino experiment at the Fermilab Tevatron Facility was approved and the run schedule is set from Jan. 1985. The Tohoku 1m bubble chamber is now used with the high resolution holography system in addition to the 3 conventional cameras. Approximately 100K pictures were taken upto now and the data are being analysed at Tohoku. Physics aims in this experiment are the detailed study of the charm particle properties and QCD effects in ν + Nucleus interactions.

Publications

1. K. Abe et al., Charm photoproduction at 20 GeV, Phys. Rev. D30, 1 (1984)
2. K. Abe et al., Study of the $\rho'(1600)$ Mass Region Using $\gamma p \rightarrow \pi^+\pi^- p$ at 20GeV.
3. K. Abe et al., Inclusive photoproduction of strange baryons at 20 GeV. SLAC-PUB-3634 (1984)

Master Thesis

1. Noriyoshi Kato, Study of Charmed particle production in 20 GeV/c γ + p interactions. (1984)
2. Yukio Yanokura, Study of the nuclear effect in ν + Fe interactions using FNAL 15-foot deuterium bubble chamber. (1984)

Doctor Thesis

1. Hiroyuki Sagawa, Study of ν + D interactions using the BNL 7 foot deuterium bubble chamber. (1984)